26 July 2023

Electricity Authority Te Mana Hiko

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Lodged by email: forecasting@ea.govt.nz

ETSI Submission: Review of forecasting provisions for intermittent generators in the spot market

ETSI welcomes the opportunity to respond to the Electricity Authority (the Authority) regarding the above consultation, published 14 June 2023. Nothing in this submission is confidential.

ETSI provides specialist power system and operations expertise, and advanced software solutions. The team at ETSI has developed world leading forecasting solutions for system operators for over ten years. We are client focused and dedicated to supporting energy businesses in addressing their complex challenges.

ETSI recommends that the Authority proceeds with option 3, a centralised model with the option for self-forecasting (hybrid model), as the forecasting arrangement to support the expected increase in intermittent generation share on the pathway to 47% by 2050. The advantages provided by Option 3 are critical to support an increasing penetration of intermittent generation for the following reasons:

- IMPROVED FORECAST ACCURACY - Wind farm operators and specialist forecast providers with appropriate data access and local knowledge of the assets are best placed to produce accurate and reliable wind power generation forecasts. With appropriate incentives, the market conditions create a competitive environment to drive forecasting improvement which directly results in increased system security.
- IMPROVED SITUATIONAL AWARENESS: The system operator will have access to both (i) their centralised forecast and (ii) the decentralised forecasts. Significant value is created when these are combined, providing the ability to compare and contrast multiple inputs which is significantly more valuable for situational awareness, to assess generation uncertainty and system adequacy, and clearly increases system security.
- OPERATIONAL FLEXIBILITY AND RESILIENCE: The overarching governance arrangements can be prescribed in the code, however the system operator can be given the responsibility and capability to determine the incentives and standards (through industry consultation) which drive continued competition and improvement, and ensure forecasts are meeting system operator requirements.

The above characteristics are key to managing the increased uncertainty and variability introduced by the growing share of intermittent generation. Further, it is important to recognise the risks to power system security that can arise due to normal forecasting errors, and for this reason the System Operator must maintain a fit-for-purpose centralised forecast in order to mitigate such risks. For this reason, Option 1 should not be considered a viable stand-alone option and should not be relied upon, as it alone does not provide the resilience or dependability required to maintain system security.

Centralised forecasts are an absolute requirement for any system operator, which should be complemented by optional self-forecasts, with appropriate incentives and penalties, in a forecasting arrangement design that fosters competition between the central and self-forecasts, to improve forecast quality over time (via technical and commercial innovation), and ultimately contributes to mitigating the risks identified by the Authority (see 3.11 of Issues and Options Paper).

Forecasting is a foundational piece in ensuring a reliable system, and without accurate and fit-for-purpose forecasts, the complexity and difficulty of managing the system increase substantially, as does the likelihood of a system contingency event. Albeit, even with the appropriate forecasting arrangements in place, there remains the risk of simultaneous multiple contingency events (e.g. additive demand and supply forecast errors combined with forced thermal unit outages) that can threaten power system security and reliability, and can lead to events such as the 9 August 2021 grid emergency. As the thermal fleet ages, and the variability and uncertainty on the demand and supply sides increase, the risk and impact of multiple contingency events increases; therefore, ETSI recommends careful consideration be given to how these risks are best managed, and to recognise that more accurate forecasts alone are not a silver-bullet that will address all issues from increased intermittent generation share of supply.

Therefore, it is important to design a forecasting arrangement and system which meets current and future demands and to provide the core building blocks of a fit-for-purpose hybrid forecasting arrangement, which are:

- Well defined, mandated data and information provision requirements for intermittent generators – this provides clarity and certainty of a) implementation costs for new entrants, and b) additional costs for existing units. The data and information provided by intermittent generators enables centralised forecasts to be developed using site-specific data which will improve modelling and forecast quality, and ensures that this data is readily accessible for centralised forecasts.
- The ability to evolve and improve incentives and penalties over time through a consultative process between system operator and stakeholders. This enables the forecast quality to improve over time as technical and procedural innovations are developed. The incentives and penalties should be designed such that they are technically feasible, are outcome oriented and are not prone to gaming.
- Capability and capacity within the System Operator to administer the forecasting arrangements. This includes day-to-day system operation, performance monitoring and reporting, and appropriate research and development to improve centralised forecast quality.

Given the difficulty and time required to implement new regulatory obligations, new systems and processes, it is critical to have:

- Sound regulatory policy, where the framework and governing arrangements are specified in the code, and the standards and operational requirements are determined by the system operator in consultation with industry.
- Experienced resources to provide the right insights and guidance when developing these requirements and systems.

We attach our response to the Authority's questions in Appendix 1. We also attach references from the AEMO and Tesla that demonstrate our expertise developing and operating forecasting systems to manage system security. With our unparalleled experience, ETSI can assist the Authority in developing fit-for-purpose forecasting arrangements for New Zealand, building on and surpassing the Australian hybrid approach, increasing the security and reliability of New Zealand's power system.

Please don't hesitate to contact us regarding any questions relating to this submission, or if we can support the Authority further through the consultation process.

Kind regards,

Anthony Hill

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Jack Fox

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Appendix 1

#	Question	ETSI Comment
Q1	Do you agree with the Authority's problem definition? If not, why not?	Yes, we agree, subject to the following: Improving the accuracy of intermittent generation forecasts will improve participant decision making and contribute to mitigating the risks identified by the Authority. However, even the most accurate forecasts still have unavoidable forecast errors. Risks due to multiple contingency events (such as the 9 August 2021 grid emergency) even with a best-in-class forecasting arrangement, will continue to grow as the energy transition progresses, and the potential impact of these risks is also getting larger. Therefore, it is imperative that the System Operator has the appropriate tools and levers at its disposal to manage these risks to the power system. This includes improvements to power system functions such as outage scheduling, resource adequacy and lack-of-reserve notification to the market. Answering the question of how intermittent generation forecasts, and the uncertainty and variability inherent in them, are best used in these processes is critical to ensuring that the power system can manage multiple contingency events without triggering a grid emergency in the future.
Q2	Do you agree that a new forecasting arrangement should apply to all grid-connected intermittent generators that are required to submit offers?	Yes, any new forecasting arrangements should apply to all grid-connected intermittent generators that are required to submit offers. The practical implementation of such a requirement must take into account the existing intermittent generators and the costs (if any) associated with retrofitting existing equipment and processes to comply with the new arrangements. In general, we recommend sufficient time is provided for existing assets to comply with new arrangements and the use of a sunset clause to ensure compliance by a given date. Exemptions and grandfathering existing intermittent generators can be provided if the owners can demonstrate that the costs to retrofit to meet the new arrangement are prohibitive, but should be avoided to the extent possible.
Q3	Note this question is referring specifically to generators who have thermal assets: For all trading periods between 1 November	We do not have thermal assets and cannot comment on how often incorrect unit commitment decisions were made. However, the relationship between thermal unit commitment lead time, forecast accuracy and incentives in a decentralised-only arrangement, and an energy-only market is complex. In an energy-only market with

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	2019 and 31 October 2022, how often do you think you made the incorrect decision whether to start or stop your thermal unit(s)? Please provide reasons why this occurred.	independent intermittent generators (i.e. generators not integrated into a load and generation portfolio), the natural incentive for these independent generators to accurately forecast ahead of time is weak. It is challenging to design standards, incentives and penalties for these generators in an energy-only market due to the complexity of how to recover costs for any incentive payments and how to distribute any penalty payments, not to mention the obvious question of how to set appropriate standards against which to measure performance. This is one of the reasons why we recommend the hybrid arrangement as the central forecast provides a basis on which to benchmark the decentralised forecast, should this be desired.
Q4	What else, if anything, should be considered when assessing the relative advantages and disadvantages of the four forecasting arrangements the Authority has identified?	See our submission above.
Q5	What other types of forecasting arrangements, if any, should be considered to improve the issue of inaccurate and unreliable forecasts?	We break this down into two parts: 1. Improving the accuracy and reliability of forecasts 2. Improving decision making whilst using forecasts 1. <u>Improving the accuracy and reliability of forecasts</u> A forecast is only as good as its inputs and without requirements on the data and information provided into forecast models (whether centralised or decentralised) the models must make assumptions that limit their forecast accuracy and effectiveness. ETSI recommends the Authority consider amendments to the code to mandate data and information provision so that a baseline level of data and information can be relied upon to build forecast models (centralised or decentralised). Refer to the Energy Conversion Model requirements in the National Electricity Market in Australia. 2. <u>Improving decision making whilst using forecasts</u> Forecasts on their own are a critical input into the broader power system functions and decision-making processes that support power system and market operation. To improve the effectiveness of these functions and processes, the integration of forecasts into these functions and processes is critical. In particular, how these functions and processes handle the uncertainty and variability inherent in intermittent generation

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		forecasts is paramount to ensure that decision making is effective. Forecasting is not a silver bullet, and the goal of a perfect forecast is flawed as even the best forecasts will have unavoidable errors. Multiple contingency events such as the 9 August 2021 grid emergency, are a growing risk, and an example of the impact when multiple seemingly unremarkable events coincide. A similar multiple contingency event occurred in South Australia on 8 February 2017 when a record demand day, combined with a demand underforecast event, combined with thermal unit unavailability, combined with wind overforecasts, leading to a lack of reserve and end-use customer load shedding of 300MW. These types of high-impact multiple contingency events are becoming increasingly probable as electricity systems around the world transition to renewable energy sources. Increasing the capacity and capability within the system operator to administer the forecasting arrangements is imperative to improving the decision making based on the forecasts. This includes enabling this function within the system operator to provide situational awareness to market participants and the control room, and improving the power system functions and processes described above to incorporate forecast uncertainty and variability.
Q6	Do you agree with the proposed evaluation criteria? If not, what is your view and why? Are there other criteria that the Authority should consider?	ETSI agrees with the Authority's evaluation criteria – the criteria support the objective of ensuring any changes are in the long-term interests of consumers. ETSI would like to emphasise the following: • For the reliability criteria – improved forecast accuracy should not be viewed as a silver bullet that will mitigate all risks to power system security and reliability. By improving forecast accuracy, the risks to power system security and reliability are reduced, however the effective management of these risks involves appropriate integration of the forecasts into power system functions and processes as described in our submission above. • For the "Uses an exacerbators pays approach" criteria – the design and implementation of such a mechanism with a decentralised-only arrangement in an energy-only market is complex for the same reasons as described earlier in

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		our submission. This is one of the reasons why ETSI recommends a hybrid arrangement.
Q7	Do you agree with the Authority's assessment of each forecasting arrangement above? If not, why not?	Regarding Table 4, we note the assessment of Option 3 regarding Efficiency (Mitigates risk of too much generation or demand response) which results in a Medium (2) score. This appears incongruous when considering the same assessment of Option 2, on the basis that better information and improved situational awareness directly leads to improved decision making by the system operator and reduced operational risk. Option 3 provides the same information from a centralised model as Option 2; however, it is complemented by having decentralised forecasts and the capability to compare possible outcomes and associated risks. Otherwise, ETSI agrees with the Authority's assessments of each option and ETSI similarly considers the hybrid arrangement the preferred option. ETSI recommends the Authority includes amendments to the code to mandate provision of data and information by intermittent generators as described throughout this submission.
Q8	The Authority has not weighted the criteria based on importance. Are there particular criteria that you consider to be more important that the others?	Whilst it is possible to weight the criteria, it may be more appropriate to ensure some of the criteria determine the minimum expectations, for example, there's not much point having a value for money system that is easy to implement and which attributes cost-to-cause, if it doesn't mitigate risks to system security (Reliability) and which meets future requirements of a renewables-based power system. Therefore, it may be more appropriate to have 1st order (required) attributes, and 2nd order (nice to have) attributes. However, we do not believe this would result in a different leading option in this case, and Option 3 would still be the preferred option.
Q9	Are there additional criteria that the Authority should be considering?	No response
Q10	How frequently do you think intermittent generation forecasts should be updated, and how often do you think intermittent generators	Improved information provision up to the moment of dispatch is a key tenet of an energy-only market, and this includes forecasts which are key component of the dispatch information. Therefore, forecasts should progressively be updated up to the moment of

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	should be required to revise their offers to reflect updated forecasts?	dispatch. The frequency of forecast updates, the temporal resolution of each forecast, and the length of each forecast should be aligned with the power system functions and processes which the forecasts underpin. In particular, the frequency of forecast updates should occur at least as frequently as the power system function being performed. Another important element to consider here is the gate-closure of the power system function and ideally, aligning the forecasting process so it delivers its latest forecasts immediately prior to gate-closure.
Q11	Do you think the Authority should implement accuracy standards? If not, please explain why.	The Authority should implement a framework within the code which requires the system operator to develop and maintain accuracy standards. In further support of the hybrid arrangement, we point out that under the hybrid model, the centralised forecast can be used to benchmark the decentralised forecasts and even act as a performance benchmark that must be bettered before the decentralised forecasts can be used. The system operator should similarly be incentivised to improve the centralised forecasts – in practice this can be achieved through in-house research and development, or through a competitive procurement and contracting process.
Q12	If the Authority was to implement accuracy standards: do you think outcome process standards would be more effective? should there be a single standard or multiple standards across different timeframes? should the standard(s) be focused on ensuring actual generation is within 30 MW of the amount that was forecast, or should the MW compliance threshold be higher or lower? should the accuracy standards be based on the percentage of installed capacity rather than a certain amount of MW?	The design and implementation of accuracy standards is a complex and challenging process to get right, which is why ETSI recommends the hybrid arrangement as described above. The centralised forecast acts as a benchmark upon which the decentralised forecasts are compared, and it can be improved over time through in-house research and development or through a competitive contracting process. ETSI agrees with the Authority's view that specifying enduring accuracy standards is inflexible, and therefore ETSI suggests that the system operator is empowered to maintain the accuracy standards which should be developed through consultation with industry and encouraged to evolve over time through a regular review and consultative process.
Q13	Following the 9 August 2021 grid emergency, reports from two investigations recommended	Persistence forecasting can be appropriate when forecasting a very short lead-time ahead, for example persistence forecasting can work well for wind generation when

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	that the Authority amend the Code to disallow persistence forecasting and require wind generations make more accurate offers to the system operator about supply. Do you agree that the Authority should amend the Code to disallow persistence forecasting?	forecasting 5-minutes ahead. Persistence forecasting is not appropriate at longer lead-times and is very risky when performed at the lead-times which coincide with thermal unit-commitment decision making. This risk is magnified when there are weather systems moving across New Zealand that lead to wind power ramping events. In these events not only is the system at risk of forecast magnitude errors, but due to the risk of temporal changes (i.e. the weather system moving faster or slower than predicted), but the size of the forecast error is magnified by the timing of the ramp.
Q14	Do you think the Authority should implement accuracy incentives and/or penalties for non-compliance? If not, please explain why.	ETSI supports the implementation of well-designed incentives and penalties. The incentives and penalties should be outcome-oriented, technically feasible and not prone to gaming. One such design that meets these criteria whilst recognising the inherent uncertainty in forecasts is the application to forecasts of a penalty deadband outside of which a financial penalty is applied. To incentivise improved forecast accuracy, the penalty payments are distributed to the most accurate forecasts within the deadband. Over time the penalty deadband can be reduced to drive further forecast accuracy improvements.
Q15	If the Authority was to implement a decentralised forecasting arrangement, do you have any suggestions for what type of incentives could be applied?	See our response to Question 14.
Q16	If the Authority was to implement a centralised forecasting arrangement: a) do you have any suggestions for what type of incentives could be applied? b) should penalties for not meeting the standard(s) be prescribed? c) should penalties be higher for over generating than under generating (or vice versa)?	If a vendor is procured to provide centralised forecasts, contract KPIs can be used for performance based incentive payments, and similarly for performance penalties. When contracts are due for renewal a competitive procurement process with multiple vendors will ensure the best commercial and technical outcomes. Any vendor contract should also consider the ability to terminate early any contract for multiple unreasonable forecast errors. ETSI recommends against different penalties for over and under generating. Penalties which encourage forecast providers biasing their forecasts can consequently lead to skewed forecasts and one-sided errors, which can accumulate reducing forecast accuracy overall and the system security benefits.

#	Question	ETSI Comment
Q17	Do you have a view on who should have responsibility for submitting forecasts and who should pay for forecasting?	Under the hybrid arrangement recommended by ETSI, the centralised forecasting performed by the System Operator is to support critical power system functions and processes. Therefore, ETSI believes that the cost of centralised forecasting and establishing capacity and capability within the system operator to administer this should be collected from all market participants via market fee recovery. The intermittent generators should bear the cost of any decentralised forecasts, which requires a well designed and effective incentive and penalty scheme. ETSI disagrees with the statement in table 5 which implies that the system operator would "turn off" the central forecast for an intermittent generator if the decentralised forecast provided for that intermittent generator was approved for use. In ETSI's experience having the central forecast is critical to the whole design of the hybrid arrangement on the basis that (i) it provides benchmarking for decentralised forecasts, and (ii) for system security purposes, such as providing situational awareness, decision making, and redundancy.
Q18	Do you have a view on what types of information should be published and what platform it should be published on?	All forecasts used in any power system functions and processes should be published publicly so that any interested stakeholders can access them. Ideally confidence interval forecasts should also be published if these were used in any decision-making processes. If there are concerns from industry about confidentiality of individual intermittent generator forecasts, then delayed publishing of the individually identifiable forecasts may be warranted, however market transparency regarding system security and mass-balance supply-demand provide valuable market signals. ETSI recommends publishing the data via an interactive dashboard as well as making the data available for programmatic access for example via an API.

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21 July 2023

Subject: Reference for ETSI

On behalf of TESLA, I had the opportunity to work very closely with both Anthony Hill and Jack Fox during their time at the Australian Energy Market Operator (AEMO) on the Operational Forecasting Team since 2017. We worked very closely with both until Anthony left AEMO to establish ETSI in 2022 and Jack joining him a year later.

When we first began working with AEMO, from a load forecasting perspective the challenge was managing peak demand resulting in times of very high temperatures in the summer. Due to the skill limitations in weather forecasting, the system was naturally very challenging to forecast. At the time, AEMO was exploring the adoption of multiple external load forecasts to introduce Consensus Forecasting: Forecasts combining several separate forecasts of different inputs and methodologies. They were already utilizing at least two independent weather forecasts.

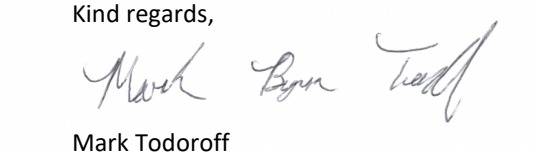
The load forecasting landscape in Australia quickly evolved with summer peak demand no longer only material concern. With the prevalence of embedded rooftop PV, minimum demand became a serious concern. Managing peak demand in the winter also became critical, particularly on cold cloudy days when the solar generation drops off.

I commend Anthony and Jack for their superb leadership as they grew a world-class Operational Forecasting team at AEMO and led the development of major forecasting solutions such as consensus and renewables forecasts as well as market data dashboards and applications for the NEM. With their progressive mindset and strategic thinking, they achieved this before it was too late. They understood the implications of increasing renewables and climate change had on the grid and had positioned the team accordingly.

Internationally, AEMO is well-regarded by other System Operators for their sophisticated Operational Forecasting Team and System. Anthony and Jack were instrumental in creating the culture and systems that make AEMO the energy forecasting powerhouse that it is today. Through their leadership they not only developed state-of-the-art forecasting systems, but also educated the control room operators on how to use these new tools. This was especially true when the forecasting responsibility in Western Australia was transferred from IMOWA to AEMO. Jack and Anthony not only worked on the NEM, but also helped implement these technologies in WA – a system with its own unique challenges.

Character-wise, Jack and Anthony are both very pleasant to work with. I really appreciated the professional yet candid communication we've had over the years. I could not recommend them enough for any System Operator or Energy Forecasting projects. Please feel free to reach out to me with any questions.

Kind regards,



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27 June 2023

Mr Anthony Hill
By Electronic Mail

To Whom It May Concern,

Reference – Mr Anthony Hill

I am pleased to provide this character and capability reference for Mr Anthony Hill. In my role as Manager Operational Forecasting at the Australian Energy Market Operator I managed Mr Hill for a period of 5 years in his role as Specialist in the Operational Forecasting department.

The AEMO Operational Forecasting department is responsible for short term forecasting (5 minutes to 7 days ahead) of demand in each Australian National Electricity Market (NEM) jurisdiction (total demand in the order of 35,000MW), the output of circa 200 wind and solar farms with a generation capacity in excess of 30MW and approximately 3 million residential rooftop photo-voltaic arrays. The department is also responsible for providing real-time situational awareness to the NEM control rooms and market participants; this includes but is not limited to lightning strikes, severe weather, bushfires and sandstorms. This function is critical to the secure and reliable operation of the Australian national grid.

In his role as specialist in the department Mr Hill was a senior member of the department leadership. He was instrumental in developing the strategic and operational plans for the department. He was also the lead in commercial negotiations with the function's portfolio of Australian and international service providers, delivering forecasting, situational awareness and IT services to the department. In his leadership role within the team Anthony regularly acted as Manager Operational Forecasting and participated on the Duty Manager operational roster supporting real time operations and the support of AEMO's control rooms. He also managed a portfolio of CAPEX and OPEX projects comprising complex technical and regulatory activities with internal and external stakeholders, IT services providers, regulatory bodies and market participants.

Anthony is a recognised domain expert in the Australian Gas and Electricity Markets. He is able to build and maintain excellent working relationships with his work colleagues, stakeholders, suppliers and customers; being particularly adept at communicating effectively in complex and nuanced situations. He is also expert at training developing and mentoring more junior staff and colleagues.

Yours sincerely,

Michael Davidson

Manager Operational Forecasting

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27 June 2023

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By Electronic Mail

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In his role as specialist in the department Mr Fox played a key role in establishing the current capacity and capability of Operational Forecasting function within AEMO. He was instrumental in developing the demand and supply forecasting models and systems, liaising with critical service providers and the integration of forecasting systems and processes with the AEMO STPASA and dispatch engines. He also has had a leadership role in the development of the next phase of forecasting tools and systems in preparation for the evolution of the Australian electricity system. Mr Fox has authored some highly respected papers on energy forecasting, is regarded as an expert in the field internationally and has presented to expert audiences both in Australia and overseas for and on behalf of AEMO.

Jack is a consummate professional. He is highly proficient technically and exhibits well developed interpersonal and communication skills. He is able to build and maintain excellent working relationships with his work colleagues, stakeholders, suppliers and customers.

Yours sincerely,

Michael Davidson

Manager Operational Forecasting

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